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Abstract

Studies of the Frequency and Power Regulation of a Power System Containing Nuclear and Water Power Stations

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In an electric power system the proportion of nuclear power is growing and consequently it will play a more important role in the frequency control of this system. Owing to the accuracy required in frequency control special demands will be made upon the frequency regulating nuclear power stations.

For this reason the suitability of using pressurized and boiling heavy water reactor plants together with water power plants for frequency regulation in the Swedish network will be studied in this paper. The Swedish network contains to-day a total power of about 8 000 Mw. The fast load variations are normally not over 1 %. In the frequency regulating stations electrical governors with a permanent statism of down to 0.4 % are used. Normally the frequency regulation is chosen so that the permanent change in power production will be a little more than 50 % of the total power at a frequency change of 1 Hz.

Studies of frequency regulation by nuclear power plants will be carried out on an analogue computer, for which reason a dynamic model of the power system is developed. The frequency regulating nuclear power stations och the other frequency regulating stations are treated as two separate parts while the remaining part of the power system is represented by a simplified empiric transfer function between power and frequency. As the compensating contribution of the remaining network to the frequency control is small in comparison to the contribution of the frequency regulation stations the accuracy of this model of the remaining network can be considered sufficient.

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The reactors of the regulating nuclear power stations are assumed to be of the boiling and pressurized heavy water types. For these stations a detailed analogue model is used, including lumped models of the reactor with control system and the steam turbines with valves and control system, so that transients in power, pressure and temperatures in different parts of the reactor system can be studied.

The conditions at both regulated and unregulated reactor power at different values of the statism of the turbine governors will be studied. Different regulating principles for adjusting the reactor power to the load as well as the influence of transients on the reactor and the main components will be investigated. A comparison between nuclear and water power stations used for frequency regulation will be done and the cooperation between these stations at various load disturbances will be specially considered.